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A total of 75 samples of different cereal species were analysed for their arsenic, chromium and zinc contents. Arsenic contents of these cereals ranged from 0.08 ppm to 1.00 ppm. These values were within the maximum permissible limit for arsenic. Chromium (0.30-5.0 ppm) and Zinc (8.8-40.0 ppm) contents of the cereals were much higher. Low standard deviation and standard error values show that the arsenic, chromium and Zinc contents of different samples of each species were compact and crowded around the mean values. However, these contents were more divergent among the different species of the same cereal.

INTRODUCTION

In recent years, trace elements have gained tremendous importance. Within the permissible limits they play important physiological functions. However, in amounts far exceeding tolerable levels, these may produce toxic effects.

Arsenic stimulates phosphorylations in living tissues and is essential for biochemical processes.[1] Arsenic also plays a role in amino-acid metabolism.[2]

Chromium is essential for carbohydrate metabolism as a co-factor of insulin.[3] It is also involved in proper lipid metabolism[4] and prevents atherosclerosis and other

associated cardiovascular diseases. Zinc has also been recognised as an essential micro-nutrient due to its important role in enzymatic functions and DNA systhesis.[5]

There is a new awareness about the occurrence of these trace elements in human food. Major sources of these elements are the foods of plant origin. Wheat, rice, maize and other cereals have been reported to accumulate arsenic,[6] chromium [7,8] and zinc[9] from soils to a significant extent.

Many reports have been published [10,11] on the composition of cereals in Pakistan; however, data on trace elements in cereals are lacking.

In view of the fact that cereals constitute a major source of energy and proteins in human diet, present studies were undertaken to assess the levels of arsenic, chromium and zinc in common varieties of major cereals grown in Pakistan.

MATERIALS AND METHODS

Materials

Five samples of each variety of wheat, rice, maize, barley, oats and sorghum were procured from the local market.

Methods

Arsenic[12] and chromium[13] were determined by spectrophotometric methods. Zinc contents of cereals were determined according to the method of Reith *et al*[14] by atomic absorption spectrophotometer model 170–10 (Hitachi Ltd) using air-acetylene flame at spectral line 213.9 nm.

RESULTS AND DISCUSSION

Arsenic

Arsenic contents of all the cereals were within the maximum permissible (1.00

ppm)[15] for arsenic in cereals. Arsenic contents of sorghum (variety sadabahar) were found to be minimum *i.e.* 0.08-0.20 ppm, while those of maize (variety: sultan) were maxium *i.e.* 0.88-1.00 ppm. (Table–1).

Standard deviations (S.D.) of arsenic contents of cereals ranged between 0.022 for oats and 0.179 for Lyallpur-73 wheat variety. Standard error (S.t) values for arsenic contents were 0.009 for oats and 0.08 for Lyallpur-73 wheat variety. (Table II). These two factors indicate extremities of the values around the mean contents of arsenic. Arsenic levels of wheat (variety Kohinoor-73) were crowded near the mean values, as is indicated by low values of S.D and S.E. Arsenic contents of other wheat varieties were more divergent and gave higher values of S.D. and S.E. Similar pattern was observed in the case of maize.

Arsenic contents of the rice samples were found to occur in narrow ranges (indicated by low S.E. and S.D. values) except those of Basmati-198 which had a range of 0.65-0.90 ppm.

Arsenic contents of sorghum (Sadabahar) and oats gave low S.D. and S.E. values, while for barley reverse was observed.

Co-efficient of variance (C.V) i.e. the percentage of scatter of individual values around the mean of sample group observations ranged between 7.02 in the case of 'K.S. 282' variety of rice and 60.68 in case of 'Akbar' variety of maize.

Chromium

Chromium levels of the cereals were found much higher than the corresponding arsenic contents. It is interesting to note that chromium contents of oats was maximum i.e. 2.7-5.0 ppm while their arsenic contents were found to be one of the lowest i.e. 0.18-0.25 ppm. Kohinoor-73 wheat variety was found to have minimum chromium contents i.e. 0.48-0.68 ppm. Chromium is beneficial in view of its importance as a co-factor of insulin[3] and its involvement in proper lipid metabolism.[4]

Values of S.D. and S.E. for chromium contents were generally much higher than those for arsenic contents. Thus chromium contents of different species of cereals were

more scattered around the mean values as compared to arsenic contents which were found to be comparatively more compact. C.V. values for chormium contents fluctuated as these represent the percentage of scatter of individual values around the mean of sample group observations and thus depend on the scatter of the values, as well as, the average values of chromium contents.

Zinc

Zinc contents of oats were found to be minimum (8.8-11.2 ppm) and those of sultan variety of maize were maximum (28.0-40.0 ppm) Zinc contents of these cereals were below the maximum permissible limit (40.00 ppm)[15]. The occurrence of zinc in cereals in such concentrations is consistent with the nutritional role which zinc plays in living systems. Zinc is associated with the development of brain and regulation of its functions.[16] It is also involved in the proper growth and maturation of nervous system.[17]

Zinc contents showed higher S.D. and S.E. values. However, C.V. values for zinc were comparable or even less than those for arsenic and chromium. Thus, although individual values of zinc contents of these species showed a much higher scatter around the means of sample group observations, yet were comparable or even less than the values for arsenic and chromium contents.

Statistical analysis of the arsenic, chromium and zinc contents of the wheat, maize and rice clearly indicate that the values of these trace elements were more compact for the individual species as compared to the cereals as a whole. Thus trace element contents were found to be genetically controlled more rigidly in the individual species.

Findings of the present studies are significant in view of the importance of these micronutrients in human nutrition. Findings of these studies warrant the urgency for a wider survey for the trace elements contents of other food crops also.

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TABLE 1. TRACE ELEMENT CONTENTS OF COMMON CEREAL VARIETIES

Cereal	Variety	TRACE ELEMENTS		
		Arsenic (ppm)	Chromium (ppm)	Zinc (ppm)
WHEAT *(Tritium aestevum)*	BLUE SILVER	0.24 – 0.60	0.63 – 0.70	16.3 – 24.0
	LYALLPUR–73	0.50 – 0.98	2.00 – 2.80	30.0 – 35.5
	PAK–81	0.65 – 1.00	0.47 – 1.00	32.00 – 38.00
	KOHINOOR–73	0.67 – 0.88	0.48 – 0.68	18.0 – 22.80
MAIZE *(Zea mays)*	AKBAR	0.11 – 0.48	1.00 – 2.00	12.7 – 19.0
	NEELAM	0.48 – 0.88	2.20 – 3.20	20.0 – 35.0
	SADAF	0.71 – 0.88	2.11 – 3.50	19.0 – 24.0
	SULTAN	0.88 – 1.00	3.20 – 4.20	28.0 – 40.0
RICE *(Oryze Sativa)*	BASMATI–370	0.20 – 0.35	0.30 – 0.60	19.40 – 30.0
	BASMATI – 198	0.65 – 0.90	1.00 – 1.60	12.0 – 22.0
	ERI – 6	0.58 – 0.75	1.20 – 2.50	18.0 – 22.0
	K.S. 282	0.75 – 0.91	2.90 – 3.50	11.0 – 18.0
SORGHUM *(Sorghum vulgare)*	SADABAHAR	0.08 – 0.20	1.5 – 2.5	12.1 – 18.0
BARLEY *(Hordeum vulgare)*	–	0.14 – 0.50	0.55 – 2.50	9.6 – 18.0
OATS *(Avena sativa)*	–	0.18 – 0.25	2.70 – 5.0	8.8 – 11.2

TABLE II: STATISTICAL EVALUATION OF TRACE ELEMENT CONTENTS OF CEREALS

Cereal	Variety	STANDARD DEVIATION			STANDARD ERROR			CO-EFFICIENT OF VARIANCE		
		Arsenic	Chromium	Zinc	Arsenic	Chromium	Zinc	Arsenic	Chromium	Zinc
WHEAT (Tritium aestevum)	BLUE SILVER	0.138	0.050	2.918	0.062	0.022	1.309	36.41	7.14	14.70
	LYALLPUR 73	0.197	0.307	2.174	0.080	0.137	0.972	22.71	13.13	6.48
	PAK 81	0.153	0.231	2.28	0.068	0.103	1.019	18.27	30.80	6.70
	KOHINOOR 73	0.082	0.081	1.714	0.037	0.072	0.766	11.16	13.96	8.42
	WHEAT	0.230	0.749	7.214	0.051	0.167	1.614	33.48	68.72	26.78
MAIZE (Zea mays)	AKBAR	0.146	0.420	2.050	0.059	0.171	0.836	60.68	30.40	12.74
	NEELAM	0.147	0.325	4.673	0.055	0.122	1.766	23.71	11.61	17.00
	SADAF	0.060	0.480	2.060	0.025	0.215	0.920	7.30	16.23	9.53
	SULTAN	0.164	0.305	4.22	0.062	0.115	1.600	18.64	8.11	12.12
	MAIZE	0.279	0.946	7.956	0.055	0.189	1.591	44.15	34.69	31.82
RICE (Oryza Sativa)	BASMATI 370	0.052	0.108	3.504	0.023	0.096	1.567	20.20	22.91	14.47
	BASMATI 198	0.105	0.245	3.484	0.043	0.100	1.422	13.80	18.84	20.70
	ERI 6	0.069	0.426	1.788	0.031	0.190	0.800	10.63	22.19	8.94
	K.S. 282	0.058	0.248	2.861	0.030	0.124	1.430	7.02	8.10	20.08
	RICE	0.232	0.941	4.704	0.052	0.210	1.052	37.12	55.68	25.00
SORGHOM (surghum vulgare)	SADABAHAR	0.048	0.313	2.00	0.020	0.127	0.816	40.73	15.82	14.38
BARLEY (Hordeum vulgare)	–	0.123	0.774	2.890	0.050	0.316	1.180	42.50	57.36	20.02
OATS (Avena sativa)	–	0.022	0.793	0.830	0.009	0.326	0.313	11.42	20.89	8.07

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